Water for the city: towards sustainability

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WATER FOR THE CITY: TOWARDS SUSTAINABILITY

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Abstract

A universally accepted operational definition of sustainability suited to a wide range of environmental issues does not (yet) exist. Nevertheless, the notion of sustainability has many dimensions relevant to urban water management. This paper aims to provide a meaningful conceptualization and operationalization of sustainable urban water management. Based on this, we identify six priorities at a strategic policy level for moving towards a sustainable urban water vision.

Keywords: urban water use, sustainability, water management

> "*Sustainable urban development is a process which will necessarily vary between cities, and evolve in different ways in each city... The very notion of what constitutes a sustainable city will change over time... Although there are few universal principles for sustainability, the ways of moving from those to policy implementation are many"* (Haughton and Hunter, 1994, p. 285)

1. Introduction

The combined trends of increasing urban demand for water services, decreasing quality and quantity of freshwater sources, and decaying infrastructure pose serious challenges as well as threats for policy makers operating in the field of water management. Critical trade-offs exist in balancing between the city and other use(r)s. Previous contributions in this volume have illustrated these trends (Kallis and Coccossis, and Swyngedouw et al.), discussed some policy options to cope with these (Dalhuisen et al. and Suzenet et al.). In the background, the concept of "sustainable development" was present in all these contributions.

"Sustainability" and "sustainable development" have come to signify a vision where present and future needs are balanced and economic, social and environmental goals mutually satisfied. Yet humans rarely, if ever, fully agree on their visions of the future and less so on how to balance their conflicting needs or desires. Sustainability with its deliberate all-encompassing vagueness, has come to mean different things to different people and waits to be meaningfully “translated” and “operationalized” for specific problem contexts. This is the objective of this paper that builds on the previous contributions in this volume to develop an operational view on sustainable urban water management.

Section 2 draws examples from urban water issues and discusses some approaches to define sustainable development. It aims at finding a contending framework. In Section 3, we turn from theory to practice and identify six priorities for action in transforming urban water management for the better. We conclude in Section 4.

2. Towards operationalizing sustainability

Over the past decade, a political consensus has emerged, defining sustainable development as “the development which meets the needs of the present without compromising the ability of future generations to meet their own needs” (WCED, 1987). This definition is normative. The basic problems with its application in practice originate from the (politically deliberate) vagueness of the word “needs”. How can the "needs" of different people doing different things, in different places and times be compared (Norgaard, 1994)?

Consider - for example - urban water issues and the difficulties in comparing the "sustainability" of water use patterns in different time periods. Were systems "sustainable" in the beginnings of this century when connection to the network was limited, a continuous supply of water rare and epidemics common? If not, then when did urban water supply turn out to become "sustainable" (or has it never been)? A consensus on this, would be a good starting point for the development of a commonly acceptable and useful definition of sustainability, but this is currently beyond reach.

In a similar vein is water use sustainable in a city like, for example, Athens where 41.5% of the rest of the country has access only to an intermittent supply and 10.7% receives only water of non-potable quality? Is Tel Aviv (or Israel) using water sustainably while virtually all wetlands in the region have been drained and many riverine ecosystems irreversibly transformed, or while within the Palestinian territory daily per capita use is less than a fifth of the Israeli average? What if "sustaining" water resources can only be done with a high energy use and potentially adverse consequences in terms of climate change?

Despite - or maybe because of - the vagueness, the concept of sustainability has become politically instrumental. It purports a basic commitment to consider the long-term implications of present decisions and to strike a balance between different choices. A pragmatic approach to sustainability has dominated. This approach aims at operationalising it as the planning or taking of actions that aim to optimise between a range of social, economic and environmental goals and the different needs of different peoples and groups. Several policy documents, plans and operational programs have put forward this approach. In most domains - including water policy - it is described with the term “integrated” denoting a holistic, comprehensive consideration of the different dimensions and responses to a problem. Generally, “integrated” refers to the combined (or optimised) aim to achieve goals along a conceptual “triangle” of:

- Economic efficiency (for example, ensuring a positive benefit-cost ratio of an intervention such as a river basin policy or a hydraulic project);
- Environmental protection (for example, protecting a valuable ecosystem such as a wetland or dune system);
- Social fairness (for example, ensuring that the cost of drinking water is affordable to low-income users).

In water resource planning and engineering terms, implementing sustainable development is conceived as the outcome of such an "integrated" approach. “Integrated water management” refers to both comprehensive solutions as well as to the combined use of structural (for example, hydraulic works) and non-structural (for example, charges or taxes) means (UNEP, 1997). The comprehensive solutions typically try to influence both the supply and demand side of the system and try to “close loops” (by, for example, waste water recycling, use of storm-water for secondary household uses, etc.).

Although planners and engineers can work with such a conceptualisation of sustainability as “maximisation within constraints”, there are increasing concerns about the time-delay associated with this technocratic approach (various contributions in Tejada and Macsimovic, 2001).

In our view, this emerging deadlock in implementation relates to the under-estimation of the fact that sustainability, a loosely defined normative concept as it is, is above all about choices and values and about informed ways of balancing (or “trading-off”) between the contradicting desires of different users of water services. The problem of deciding on what constitutes “needs” and how to balance those of different - present and future - humans (or even non-humans) is always there. Simply restating these diverse needs and committing to their balance does not help much in finding out how to balance them.

We argue therefore that sustainability as a normative and not a technical concept is not about finding the *right* answer to a given problem but about finding a *satisficing* definition of the problem representing the multiple implicated perspectives and the way to go about solving it (Giampietro, 1999). Sustainable development is therefore much about deciding on the “kind of world we want to live in and then try to manage the process of change as best as we can approximate it” (Lewontin, 1997). We support this thesis below by invoking to the example of multi-criteria decision-making as the methodological analogue to the conceptualisation of sustainable development as a multi-objective concept.

Multi-criteria evaluation methodologies have been developed as a valuable planning tool for deciding on policies and actions for sustainable development (for example, Nijkamp et al., 1990). Multi-criteria evaluation refers to the ranking of alternative options (or decisions) upon their score with respect to a set of decision-relevant dimensions (or criteria). With reference to sustainable development, criteria would fall along the three sides of the conceptual “triangle” of social, economic and environmental dimensions and include dimensions such as the cost of alternatives, environmental impact, and social, geographical and inter-generational equity. Oversimplifying for a rich range of advanced multi-criteria methodologies, the “philosophy” of the process includes:

(i) an assignment of “weights” (by experts or the policy-makers themselves) to the different criteria of comparison or “dimensions” of sustainability. For example, in deciding for the construction of a new dam versus a series of other alternatives, decision-makers can decide to value an “x” Euro increase in cost twice as important as an “y” increase in environmental impact (expressed in, for example, terms of reduced downstream flow);

(ii) the determination of the “score” of each alternative in terms of each criterion by means of scientific analysis. In this step, the cost of among others the environmental impact are determined;

(iii) the normalization of results, given their “weight” of importance and the selection of the alternative with the highest overall “score”.

However, any multi-dimensional valuation critically rests on the underlying weighing scheme, i.e. deciding on the relative importance of the different criteria or goals (Martinez et al., 1998). Yet, it is exactly this weighing that matters and creates most of the tension. What is the relative weight between, for example, safeguarding water for the city versus maintaining it for aesthetic, cultural or environmental purposes in its local regions? Whose “needs” should be prioritized in a basin where water is shared between two cities of different countries? Clearly, different people will weigh criteria differently.

Furthermore, there are various levels of scientific ignorance or inherent uncertainty in determining the “impact score” of each alternative. Kallis and Coccossis (this volume) exposed briefly the case of river Kennet in Thames and how very different - all scientifically credible - opinions existed about the potential contributions of demand-side measures in saving water. At the end, it was the court that had to decide between the different positions and effectively had to define “sustainable development”. Scientific uncertainty is judged differently by different people.

Martinez et al. (1998) make a plea for an evaluation process where “it is possible to consider a large number of data, relations and objectives which are generally present in a specific real-world decision problem, so that the decision problem at hand can be studied in a multidimensional fashion”. And they add that “[there is no] algorithmic solution of multi-criteria problems [but] methods useful for environmental policy must offer a consistent framework aimed at helping the structuring of the problem and the evolution of the decision process”. Functowicz and Ravetz (1994) in what they call a “post-normal science” for complex sustainability-related problems stress the need to deal with varieties of uncertainties and degrees of “burden and proof” through an institutionalised social process where the “laymen” become part of the scientific peer community and participate in an evaluation based on a pluralism of methodologies and perspectives. In this new context, planning and decision-making (evaluation) for sustainability transform from an elitist and pre-determined process of finding a scientifically objective solution into a participatory and iterative process (Vlachos, 1982).

The discussion so far illustrates that getting along with implementing sustainable development at the end is first and foremost an issue of finding new effective institutionalised social processes (and not necessarily courts) to come up with informed decisions and visions on the balance between the three sides of the "triangle". This requires a shift in emphasis from a "substantive" definition of sustainability to a "procedural" one (Giampietro, 1999). Participation and new structures of democratic governance are not just ways to ensure that pre-selected "rational" decisions are "acceptable for the public", as is often implicitly assumed in many plans, but about finding the "right" (that is, acceptable or satisficing) decisions *per sé*.

This, however, should not be taken as a case of relativism. A process, however democratic, might choose for "un-sustainable" paths. An informed debate with the best possible use of science is a pre-requisite. More so is a commitment to caring about the future and considering implications and impacts of present decisions.

Also, the importance of the economic dimension should not be underestimated. Bromley (1990) usefully distinguishes the notion of "cost effectiveness" from that of "efficiency". While the latter provides a universal (and theoretically ideal) normative criterion based on a given value structure (maximization of utility), the primer (practically useful) concept suggests to opt for least-cost ways to satisfy society's collectively determined preferences. An "efficiency approach" would call for the primacy of full-marginal cost pricing or liberalization of water markets and services. In contrast, a "cost-effective" approach would favor more carefully designed, context-tailored solutions such as a tariff system based on demand analysis, supplemented with subsidizing the weaker users or various forms of public-private partnerships with the aim to accomplish a multi-dimensional range of goals.

In conclusion, we have specified more precisely the "triangle" of sustainable development into the following three objectives:

- Establishing appropriate democratic governance structures for the taking of fair decisions through the informed multiple expression of values of the implicated actors;
- Developing and implementing tools for the cost-effective achievement of the decided goals;
- Committing to a future-oriented approach with an emphasis on handling uncertainty and risks.

In the next section, we will formulate some key practical actions that can transform the management of water for the city towards this "sustainable" ideal.

3. From theory to action

We identify six key priorities to transform the management of water for the city towards the sustainability ideal presented in the previous section. The key actions are all at a strategic level and they are – when possible – supported with real-world successful examples to indicate their feasibility and relevance.

Priority 1 - Operationalize participatory governance

Reaching a situation of public participation and a "citizens' democracy" is the first strategic goal. It is important to experiment with different possibilities to actively involve citizens in “critical” urban water issues (such as deciding on new projects versus water conservation, changing prices, and changing regulatory regimes).[1]

As an example, in El Paso (Texas) a new tariff policy was designed by a 27 member citizen committee representing all interest groups of the local society (including representatives of industries, environmental NGOs, trade unions, etc.). This “Public Water Committee” held a series of meetings with utility officials and was informed on issues of demand and conservation options, costs, etc. It agreed on a new tariff structure with increased bands, while committing to a revision of prices every second year (Suzenet et al., 2001).

River basin agencies and planning or evaluation procedures as foreseen in the new EU water framework directive provide an institutional “substrate” for such democratic decisions on water issues (Kallis and Nijkamp, 1999). The directive specifically asks for public consultation in all planning and licensing decisions. River basin authorities have to explicitly state in their periodic reports how they implemented this principle (CEC, 2000). On the one hand, it is a question how such a mandate will be implemented in cases where in the past some users (such as metropolitan areas) had a *de facto* primacy on decisions relating to the allocation of water. It is also important how it will co-opt with the tendency for liberalization and privatization of the urban water sector, which unavoidably removes many of decisions from the public sphere. A strong and enforceable regulatory framework which sub-ordinates the (private) water utilities to regulating (public) river basin structures is critical in this respect.

Participatory decision-making can not be developed in “vacuum” but only with a conducive social, political and institutional environment. Experience in Tuscon (Arizona) shows that this is feasible. There, a citizen's group legally succeeded in initiating a petition for a "Water Consumer Protection Act". This forced the city's water company to stop using a lower quality water from the Central Arizona Project and instead use it only to replenish and use local aquifer of a higher quality (Suzenet et al., 2001).

Priority 2 - Integrate Policies

Urban water issues fall on the interface between several policy domains and respective agencies. They touch upon a wide range of issues such as environmental protection, public health and regional-urban development.

Let us consider the situation in the EU as an example. At this level, relevant policies include the water framework directive, drinking water directives (setting public health standards), regional support funds (subsidizing the hydraulic infra-structure of cities in less-developed regions), the URBAN II financing initiative (funding urban renovation projects including investments in water use efficiency) and the common market policy (with a trend towards liberalisation of water services). We refer to

[1] A new EU research project focuses exactly on the development of tools and processes for the participatory evaluation and decision-making in conflicting projects (for example dams and transfers) at the river basin scale and in lines with the philosophy of a “post-normal” science. For detailed information on this project, see “ADVISOR: Integrated Project Evaluation for Sustainable River Basin Governance” (http://gasa3.dcea.fct.unl.pt/ecoman/advisor/).

reader to Boymanns (2001) for details. In the case of Athens, for example, the potential for the subsidization of new hydraulic infra- structure by EU Cohesion funds has been suggested as an indirect factor behind the careless management of the city's water resources in the 1980s (Kallis and Coccossis, 2000). In the region of Guadalquivir, to mention another example, mal-incentives to agricultural producers can be traced back to the Common Agricultural Policy (CAP) that leads to an over-consumption of water for the irrigation of water-intensive crops, while at the same time the city of Seville faces a critical water shortage situation (Murillo and Mateos, 2000).

Relating environmental objectives with economic objectives and financial decisions should be a major priority. At the EU level, some improvement was achieved in this respect through the imposition of the general requirement that policies such as regional funding should conform to environmental policies. As a result, new hydraulic projects can not be easily subsidized if they do not conform to the goals of the WFD (Boymanns, 2001). Further improvement could include the establishment of formal institutions for such integration. In the U.S. for example, financing of hydraulic works of utilities by the Bureau of Reclamation rests upon the binding proof that a water conservation programme has been first implemented (as defined in detailed guidelines of the Environment Protection Agency). See Suzenet et al. (2001) for details.

At the city level, little coherence exists between urban (housing, land-use, etc) and water planning processes even in areas with a strong planning culture (IAURIF, 1997; Kallis and Coccossis, 1999). Improvement could be achieved by the formulation of mutually-binding legal acts and plans and co-operation of relevant authorities in decision-making (Kallis and Coccossis, 1999). In England and Wales, for example, the regional environmental agencies have become statutory consultees in the regional and urban planning process and have pushed towards incorporation of the specificities of model “catchment management plans” into land use plans and housing allocations (Slater et al, 1994). In the Netherlands, the fourth national water plan has defined water systems and ecology as the basis for further urbanization. Water resources and respective national and provincial plans should be explicitly accounted for in national, provincial and local “town and country” plans.

A final source of policy incoherence that we want to point at is that between the regulatory rules and incentives for (privatized) water companies and environmental (integrated water management or conservation) goals. In Athens, for example, the recent law for the city's water company wrote-off all debts and interest payments relating to the repayment of the cost of the construction of the city's main surface water reservoir. Furthermore, any additional costs incurred by the water company in the case of a water deficit (when energy intensive sources will have to be utilized) will be paid by the state (Kallis and Coccossis, 2000). In this way, the water company does not face the real cost of its policy of expanding water supply to surrounding metropolitan municipalities and does not have a real incentive for water demand management. The real cost of water to the company and the price eventually paid by the end-user continues to be subsidized. Integrating water management objectives with regulatory regimes necessitates a clear addressing of possible interactions at an early stage (that is, when privatization is being planned) and the presence of regulators that have the capability to monitor and enforce a balance between the diverse goals entailed. In England and Wales, for example, after the first years of privatization which saw soaring leakage rates, leakage reduction has been legally set as a responsibility of the companies and compliance has been linked to the periodic revision of prices by the regulator (Howarth, 2000). Water companies are also asked to prepare long-term water resource management plans, which the environmental regulator cross-checks with the regional environmental and catchment management plans. Furthermore, they have to report annually on their water conservation activities. All these elements are taken into account when the environmental regulator has to decide on whether to grant a new abstraction or impoundment license (Howarth, 2000).

Priority 3 – Price properly

Dalhuisen et al. (this volume) identified the basic dimensions of a pricing system while Kallis and Coccosis (this volume) highlighted the challenge of designing water tariffs that combine conservation incentives with affordability.

Relevant instruments in terms of pricing regimes include:

- Targeted-pricing, that is, based on a tailored design of tariff bands and differentials after a careful study of actual domestic demand patterns in order to decide at what level of use prices should change and how big that change should be to be noticed by the end-users (Hanemann, 2000);
- Peak–load (for example night-only), seasonal (for example summer specific) or excess-use tariffs (for example, fines for excessive increases in use between summer and winter, or consecutive years);
- Cross-subsidization between users through the tariff design, comprehensive social packages whereby assistance is provided in relation to water charges (for example, through the social benefits system), tax rebates and rate reliefs for specific groups (for example, big families, people on benefit and specific deprived neighborhoods). See PCE (2000) for details;

and in terms of cost recovery:

- "Forward-looking" determination of prices, that is, prices that reflect present and future impacts of current water use, rather than past impacts (Hanemann, 2000);
- Recovery of some additional service charges for targeted environmental present and future interventions (for example, as in England and Wales where abstraction levies finance the activities of the Environmental Agency).

While a general trend of changing price systems is being observed, this is generally confined to increases of charges that typically account for exceptional (for example, drought-related) or accumulated costs or to the introduction of metering of previously un-metered supplies. Currently, there is limited evidence on the effects of the introduction of innovative pricing schemes as the ones described above (Kallis and Cocccossis, 2001). This is a definite priority for the near future.

Priority 4 – Act proactively

Risks for urban water systems are increasing. These relate to climate change and the associated increasingly irregular weather events, the continuation and intensification of diffuse pollution of drinking water sources (with micro-pollutants which are difficult to detect and for which it is difficult to assess health impacts), or even the threat of an intended sabotage of drinking water supply. Given the enormous size and extent of coverage of metropolitan water supply systems, being ready to face a supply or public health crisis is a major priority. Furthermore, in the case of drought management, learning to deal with a crisis might be a much more cost-effective approach than ensuring a maximum storage capacity in advance. While in the past responses developed reactively in response to emergencies (for example, deciding to construct dams in drought periods), a major contemporary priority is to move towards pro-active models of management where future uncertainties are incorporated into today's decisions and where plans are established to deal with contingencies (del Moral and Bakker, 2001). This includes a combined policy of intensive monitoring of relevant parameters coupled with standardized emergency procedures and rules of action. *Contingency plans* refer to the establishment of such standardized procedures in the case of an emergency.

Drought Planning, for example, may include activities such as assessment and ranking of prospective impacts, vulnerability assessment of population groups, cost-benefit comparison of alternative measures, enactment of legislation in advance and a pro-active water conservation program (Suzenet et al., 2001). Relevant actions include, among others, development of early morning systems, on-line data collection networks, state of the art models for medium–range weather and rainfall forecasts (Suzenet et al., 2001). Rules of action for contingency periods that allow for, for example, the use of lower quality water sources, facilitation of transfers from excess uses, special tariffs or bans on certain uses, are all relevant. A good example is Seville, where the municipal water supply company has produced a drought contingency plan (Murillo and Mateos, 2000). Hydrologic indicators and data from the city's reservoirs are used to define four stages of drought from an alert to an emergency phase. For each stage, increasingly intensifying measures are foreseen, both institutional (for example, setting up a regional Drought Committee, or the major issuing a drought order) and practical (such as taking water from neighboring reservoirs allocated to energy production and irrigation, increasing prices, applying water conservation in public buildings and forbidding certain uses).

The approach is equally relevant to contamination-related contingency planning. In Amsterdam, the municipal water department continuously monitors the quality of river Rhine. A warning system guarantees that in the case of an accident such as an oil spill, the gates transferring water from the river will be closed, with water reserves sufficient to satisfy regular demand for up to 6-months being stored in a dune area (Dalhuisen et al., 2000).

Priority 5 – Operationalize conservation

Water conservation is a precautionary, pro-active approach to future water problems and beneficial *per sé* in terms of conservation of valuable ecological resources such as wetlands, and rinerine and lake ecosystems. Although cost-benefit comparisons of conservation with supply alternatives should be striven for, given the ambiguity of relevant data and "valuations" some initial policy commitment to conservation *per sé* is necessary (Baumann and Bolland, 1998). There is still much to be done to establish water conservation on an "equal footing" with supply options at the decision-making level of the water utility or river basin agency. Priorities include:

- More micro-component data on domestic demand patterns (for example, water use per user type, income and price elasticity of different users' demands, effects of weather on water demand, etc.). This is essential as a basis for sound demand forecasts and accurate water resource planning and necessary in order to evaluate the potential benefits of demand-side interventions (Hanemann, 2000);
- Evaluation of the actual results of implemented - rather than theoretical - water conservation measures. This will help to standardize comparisons with supply alternatives and help to overcome managers' reluctance (Howarth, 2000);
- Ban on subsidies of water-supply works and operational costs;
- Inclusion of water conservation costs (for example, for renovating the network, retrofitting domestic appliances, etc.) in capital investments instead of operational costs, similar to traditional hydraulic works.

The presence of a long-range planning process facilitating a multi-dimensional evaluation of conservation and supply alternatives is also essential. "Integrated Resource Planning" is an emerging utility concept in the U.S., denoting such future-oriented, least-cost planning with a community participatory process for the expression of values (Beecher, 1998).

Acting upon the "higher-order" institutional bias that hinders water conservation at the utility level is also essential. Integrating water companies' regulation with conservation objectives was mentioned above. In England and Wales, for example, in the first years of privatization, performance was evaluated upon the quantity of water produced, as measured at the exit of the treatment plants. The regulator soon realized that this provided a mal-incentive for acting on network leakage as this showed up as increased water production. Soon this was changed to the amount of water "delivered", providing incentives to improve leakage control (Marvin and Guy, 1997).

Priority 6 – Allocate water and investments

Achieving a fair and efficient allocation of common water sources between cities and other use(r)s will be a final key issue in the near future. A combination of a public organization and regulation (such as river basin authorities and allocation plans, rights' compliance monitoring schemes) with market mechanisms like water markets and banks for the flexible transfer of water to where it is needed most appears to be the way forward.

Yet, setting and enforcing rights where they do not exist (for example, for environmental uses) or where custom prevails (for example, for old ground-water abstractions or traditional riparian rights), is a daunting task. In Greece and Spain, for example, the provision in the national Water Laws for the establishment of minimum acceptable environmental river flows, have remained largely inactive (Kallis and Coccossis, 2001; del Moral and Bakker, 2001). If environmental protection is to go a step further than simply mitigating the impacts of pre-determined works, such “rights” must be firmly established and respected in water allocations and licensing. Again, in Greece and Spain, while the recent laws foresee a licensing procedure for all ground-water abstractions, little effort to control old, “customary” users is foreseen. In England and Wales, a government initiative to review old customary water rights and substitute them with 15-year limited abstraction licenses has been highly contentious and the government has had to appeal through a more voluntary approach to “truly responsible abstractors … with environmental credentials” to surrender their rights. This is still a slow process (Castro et al., 2000).

A balance is also needed on the upstream side between pollution control and raw water treatment. A pro-active approach acting to reduce pollution at the source rather than intensify treatment makes sense both cost-wise and in terms of minimizing risks as many micro-pollutants are anyway difficult to detect and their health impacts are still not fully appreciated. “Draconian” measures that simply prohibit and ban activities around the sources are difficult to sustain. In Athens, for example, the local population around the main city’s artificial reservoir increasingly reacts to a land-use code which prohibits agricultural cultivation and construction of road infrastructure that would improve the accessibility of the poor region to Athens (Kallis and Coccossis, 2000). Implementing the “polluter-pays” principle at a river-basin level makes sense as polluters (and eventually product-purchasers) would be asked to pay for pollution-related costs instead of the urban water utility (and eventually urban end-users). Compensation packages where the urban water utility would itself invest in upstream pollution reduction also make sense and create less tension as the cost is not borne by the locals. A good example is the city of New York. Instead of constructing a new filtration treatment plant to treat its increasingly polluted inland water sources, it opted for purchasing small parcels of land around the reservoirs, it applied covenants on the use of fertilizers in the catchment, and it made a one-off investment of around US $1 billion for upgrading local sewerage plants. The purchase of land was funded through private restoration bonds with excellent rates of returns (Platt and Morrill, 1997).

To these six strategic priorities, the need for better and more comprehensive collection of information should be added as a horizontal task. Existing information systems are geared to the management approaches of the past; data typically available reflects the operational, supply-oriented priorities of the utilities. Turning into more sustainable models of management should co-evolve with improved understanding and more stochastic information on climatic and hydrological patterns, micro-pollutant levels and trends, better understanding of consumption patterns and determinants, use of accurate indicators for leakage, etc. Moreover, channels of data and knowledge exchange between cities could facilitate transfer of the experience with the new, innovative measures.

4. Conclusions

Cities can not exist without water. Securing a continuous, healthy and affordable water supply has been a pre-requisite for urban development. Envisaging a new way for managing water can only be part and parcel of the "sustainable city of tomorrow".

The sustainable city of tomorrow has to develop innovative democratic structures upon which critical and scientifically uncertain decisions will be taken with the participation of informed and active citizens. Urban water decisions, such as to build a new dam or to conserve water, how to price water or how to establish "environmental flows" need to be subject to such participatory structures and integrated at a river basin level of planning and decision–making.

The sustainable city of tomorrow will be productive and effective in reaching its shared goals. Effective economic instruments, such as prices, markets or private partnerships in the provision of services, will be utilized to reach the collectively defined and publicly regulated goals.

The sustainable city will no longer continue to expand its water frontier over farther distant regions and ecosystems. Technological developments will be utilized to ensure local, small–scale community solutions to the growing peripheral residential nuclei with the utilization of sources of secondary quality for secondary uses, without sacrificing health safety standards. Commitment to a policy of water conservation will ensure a stable individual domestic demand while maintaining a fair access of all to the service. Partnerships and integrated programs with source regions will ensure that pollution trends will be reversed. Crises will be handled by established contingency procedures.

Perhaps, the above vision appears utopian. It is in our view, however, no more utopian than the belief that business can continue as usual and that the present level, quality and affordability of urban water services will be indefinitely sustained. It is certainly difficult to materialize any "sustainable" vision, but as some flowering examples around the world demonstrate, it is worth the effort.

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